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(54) Photovoltaically powered apparatus for condition monitoring; liquid level monitoring

(57) A local condition in a machine is monitored by an indicator energised by a photovoltaic array 16 in response to a sensor 10A, 10B. the apparatus is safe in use in a hazardous environment and may be used for monitoring oil levels in mining machinery when array 16 is illuminated by a miner's cap lamp. The indicator has LED's 1 to 5 connected to corresponding reed switches selectively closed by a magnet in a float in a liquid level sensor 10A or 10B. A switch 18 allows any one of a plurality of level sensor 10A, 10B to be connected to array 16 and indicators LED 1 to LED 5.

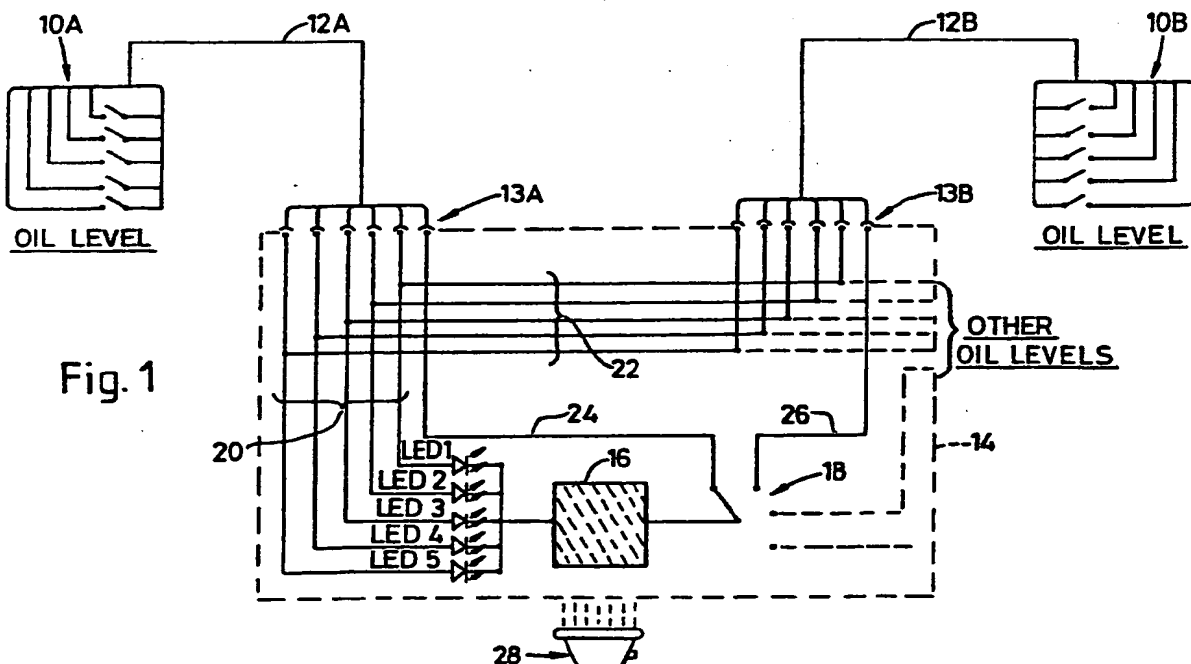


Fig. 1

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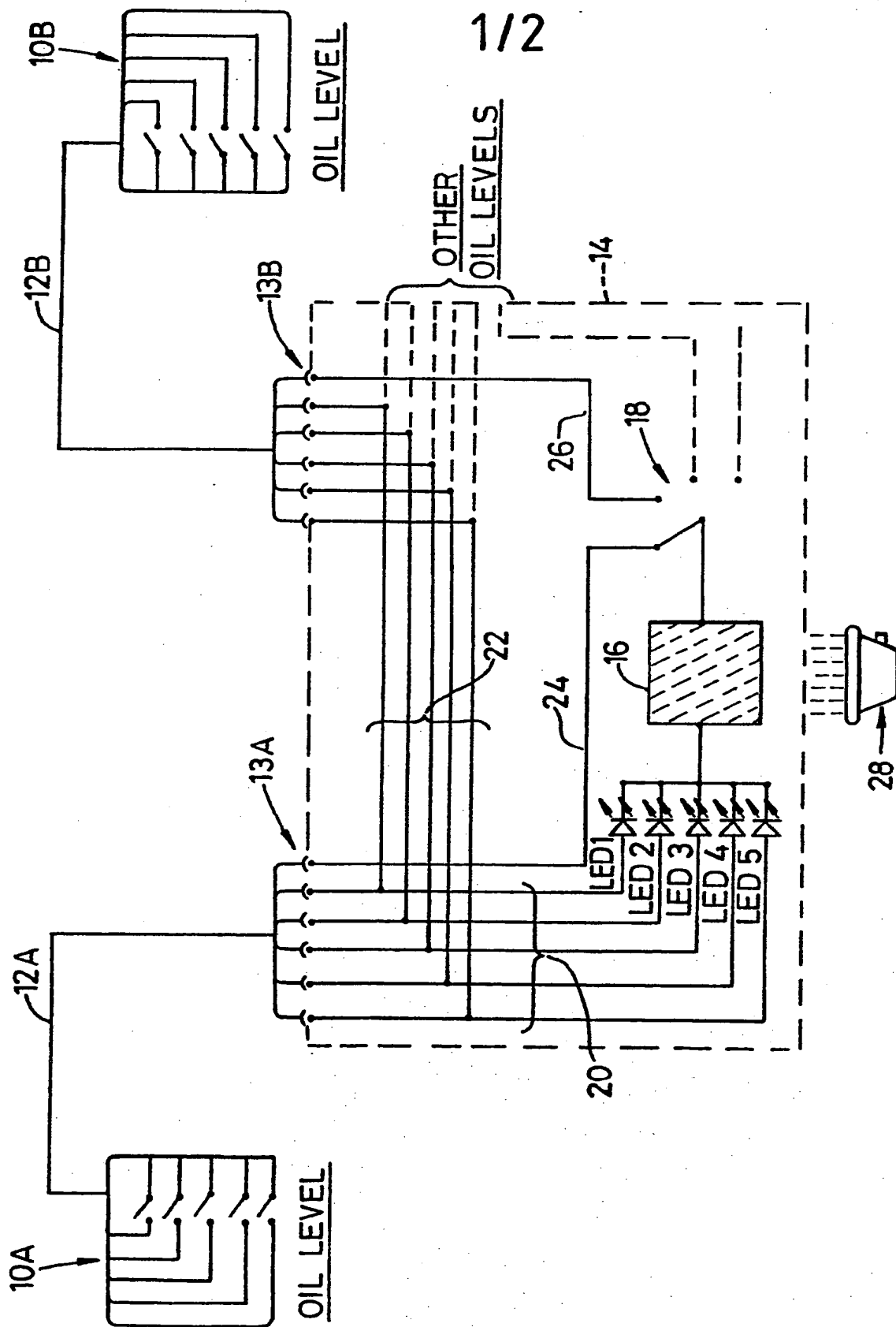


Fig. 1

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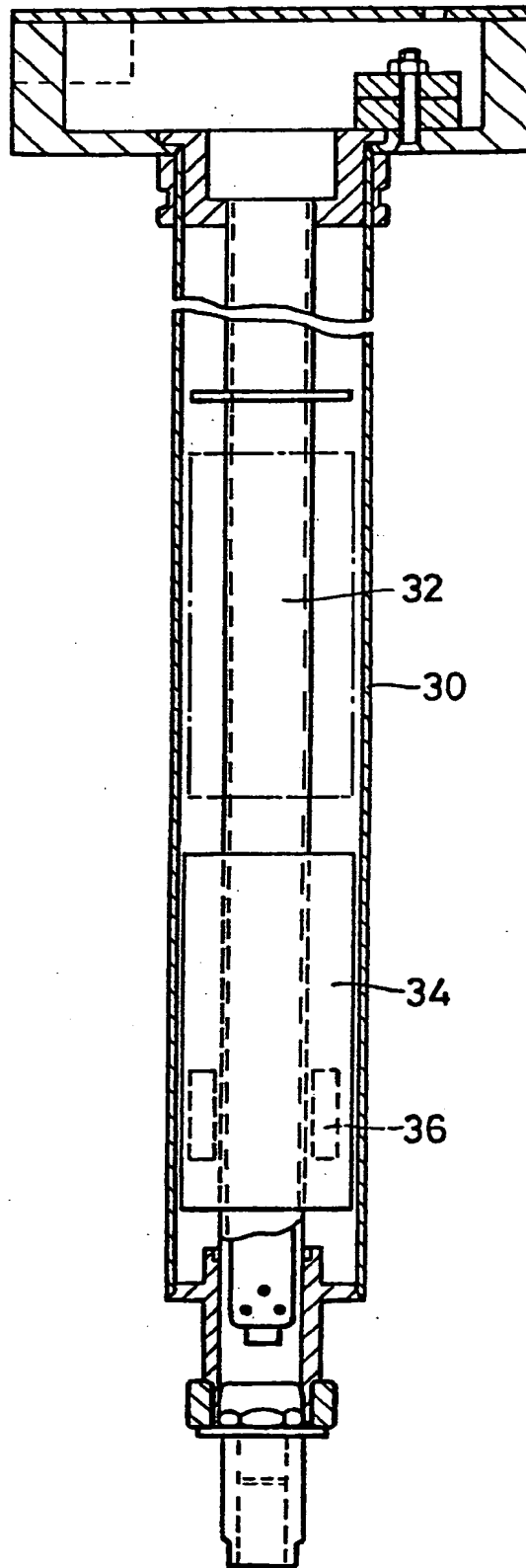


Fig. 2

"Photovoltaic Condition Monitoring Apparatus"

This invention relates to apparatus for on-site monitoring of a condition in a piece of machinery and is particularly concerned with monitoring conditions such as oil levels in machinery in hazardous environments such as mines.

Conventional means for monitoring machine conditions such as liquid levels present difficulties in a mining environment, either because they are physically difficult to accomplish (as with dipsticks, for example) or because the monitoring system must be made flameproof or intrinsically safe (hence adding to the complexity and expense of electrical monitoring systems).

It is an object of the present invention to obviate or mitigate these disadvantages. It is a further object of the invention to provide a monitoring apparatus which is of simple construction, and which is convenient, reliable and safe in use in a hazardous environment.

In accordance with the present invention, apparatus for on-site monitoring of a local condition in a machine comprises electrically operated indicator means adapted for connection to a sensor means installed in the machine, such that said indicating means provides an indication of the condition being monitored when energised by an electric current, and means for energising said indicator means comprising photovoltaic effect means adapted to generate a current to energise said indicator means when illuminated by a light source.

Preferably, said photovoltaic effect means is adapted to generate the required current in response to the light provided by a miner's cap lamp.

Preferably also, said indicator means comprises a plurality of light emitting diodes (led's).

Preferably also, the apparatus is adapted for use with a liquid level sensor.

In a preferred embodiment, the apparatus is adapted for use with a liquid level sensor of known type, including a plurality of switching elements which operate in response to the liquid level being monitored, the apparatus including a plurality of led's, each adapted for connection in series with one of said switching elements and connected in parallel with

one another to said photovoltaic effect means, such that, in use, when the photovoltaic effect means is illuminated by a light source the led's provide a visual indication of the liquid level sensed by the sensor.

It is further preferred that the apparatus is adapted for connection to a plurality of sensors and further includes switching means whereby the apparatus can be connected selectively to the switching elements of each sensor.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a schematic diagram illustrating an embodiment of the invention; and

Fig. 2 is a sectional side view of a liquid level sensor of known type, with which the apparatus of Fig. 1 is intended to be used.

Referring now to the drawings, in Fig. 1 the reference numerals 10A and 10B indicate first and second arrays of reed switches, each of which forms part of a liquid level sensor, and which operate in response to variations in the level of a liquid being monitored. The sensors, which are of known type, will be described in more detail below.

The switches of each array 10A and 10B are connected by multi-core cables 12A and 12B and suitable plugs and sockets 13A and 13B to a monitoring apparatus, generally designated 14 comprising a plurality of led's LED 1 to LED 5, corresponding in number to the number of switches in each array 10A and 10B, an array of photovoltaic effect devices 16, and a multi-position switch 18.

The led's LED 1 to LED 5 are each connected between one side of one of the switches of each array 10A and 10B, (via conductors 20 and 22, the plugs/sockets 13A, 13B and cables 12A, 12B), and one side of the photovoltaic array 16, the other side of the switches being connected to the other side of the photovoltaic array 16 via the cables 12A, 12B, plugs/sockets 13A, 13B, conductors 24 and 26 and the switch 18.

In the drawings, the switch 18 is connected to conductor 24, such that the switches of array 10A are each connected in

series with one of the led's LED 1 to LED 5 and are all connected in parallel across the terminals of the photovoltaic array 16. Thus, when the photovoltaic array 16 is illuminated by a suitable light source (in this case a miner's cap lamp 28), current will flow around each branch of the circuit in which the reed switch is closed and the corresponding led will light up, thereby providing a visual indication of the liquid level being sensed by the sensor. Switching the switch 18 to connect the second array 10B to the photovoltaic array 16 allows the level being sensed by the second sensor to be monitored. As is indicated in the drawing, the apparatus may be adapted for the simultaneous connection of additional sensors, any one of which may be selected for monitoring by means of the switch 18.

Fig. 2 illustrates a known type of liquid level sensor suitable for use with the apparatus 14 of Fig. 1. The sensor comprises a free-flooding cylindrical casing 30, a cylindrical stem 32 extending along the central axis of the casing 30, and a cylindrical float 34 which is slidable along the stem 32. A plurality of reed switches (not shown) are located at intervals along the interior of the stem 32, and a magnet 36 is mounted in the float 34. The sensor is positioned with the casing 30 depending into the liquid to be monitored, such that the position of the float 34 varies with the level of the liquid, and the reed switches operate in response to the proximity of the magnet 36. The state of the switches thus gives an indication of the liquid level, which in turn is indicated by the illumination of the led's in the monitoring apparatus 14.

The apparatus thus provides a simple, safe and reliable means for on-site monitoring of liquid levels in machines in a mining environment, and could take the form of a compact, portable module to be carried by the operative and connected as required to sensors installed in machinery, or it could be installed permanently (or removably) in machine having a number of sensors requiring periodic monitoring.

The invention may be adapted for use with other types of sensors and/or indicating means, and to monitor parameters other than liquid levels.

### Claims

1. An apparatus for on-site monitoring of a local condition in a machine, comprising electrically operated indicator means adapted for connection to a sensor means installed in the machine, such that said indicator means provides an indication of the condition being monitored when energised by an electric current, and means for energising said indicator means comprising photovoltaic effect means adapted to generate a current to energise said indicator means when illuminated by a light source.
2. An apparatus according to claim 1, wherein the apparatus is adapted for connection to a plurality of sensors and includes switching means for selectively connecting said photovoltaic effect means and said indicator means to any one of said plurality of sensors.
3. An apparatus according to claim 1 or claim 2, wherein the apparatus is adapted for use with one or more liquid level sensors.
4. An apparatus according to claim 3, wherein said one or more sensors each includes a plurality of switching elements which operate in response to the liquid level being monitored.
5. An apparatus according to any one of the preceding claims, wherein the indicator means comprises a plurality of light emitting diodes.
6. An apparatus according to claim 5 when dependent upon claim 4, wherein each light emitting diode is adapted for connection in series with one of the switching elements of one of said one or more sensors and connected in parallel with one another to the photovoltaic effect means.
7. An apparatus according to claim 4 when dependent on claim 2 or to claim 5 claim 6 when dependent upon claim 4 and claim 2, wherein said switching means are adapted to selectively connect said photovoltaic effect means and said indicator means to the switching elements of one of said sensors.

8. An apparatus according to any one of the preceding claims, wherein said photovoltaic effect means is adapted to generate the required current in response to the light provided by a portable lamp.
9. An apparatus according to claim 8, wherein the lamp is a miner's cap lamp.
10. An apparatus for on-site monitoring of a local condition in a machine substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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